

A new pseudorthoceratid cephalopod from the Kazanian (middle Late Permian) of Japan

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Abstract. A new cephalopod species, *Dolorthoceras nakazawai* (Orthocerida: Pseudorthoceratidae), is described from the Permian Mizuyagadani Formation, Central Japan. Its Kazanian age, based on a fusulinid species, makes this the youngest record of *Dolorthoceras*. This is the first undoubted occurrence of the genus in Japan.

Key words: *Dolorthoceras nakazawai* sp. nov., Orthocerida, Mizuyagadani Formation, Permian, Kazanian

Introduction and geologic setting

A new pseudorthoceratid cephalopod species, *Dolorthoceras nakazawai*, is described from a float block of limestone in the upper reaches of Ichinotani Valley in the Fukuji area, Gifu Prefecture, Central Japan. The vicinity of the collecting site is underlain by the Mizuyagadani Formation (Igo, 1956), which consists mostly of clastic sediments and has a "lenticular" limestone in its upper part (see fig. 2 in Niko *et al.*, 1987). The cephalopod-bearing limestone consists of bioclastic wackestone and has a characteristic appearance that is dark gray micrite, with sporadic crinoid fragments as the main allochemical constituent, and is identical in lithology with the "lenticular" limestone noted above. With the exception of apparently reworked fossils, the age of this formation has been discussed on the basis of foraminifers (Okimura *et al.*, 1984), radiolarians (Niko *et al.*, 1987; Umeda and Ezaki, 1997), corals (Kamei, 1957; Igo, 1959), brachiopods (Kamei, 1957) and cephalopods (Niko and Nishida, 1987; Nishida and Niko, 1989). Among them, radiolarians in tuffaceous mudstone and acidic tuff range from Sakmarian (middle Early Permian) to Midian (middle Late Permian), and ammonoids reported by Nishida and Niko (1989) are the only fossils known from the "lenticular" limestone excepting crinoid fragments. Although the precise age of the limestone is a pending question, we found the index fusulinid *Parafusulina* cf. *kaerimizensis* (Figure 1), associated with the pseudorthoceratid cephalopod *Dolorthoceras nakazawai* sp. nov., from the same locality and in limestone of similar lithology (but from another float block). It is possible that this limestone is a redeposited olistolith or has been introduced by faulting, but its age can be

determined by the presence of *Parafusulina* cf. *kaerimizensis*. Based on the assembled evidence, we conclude that the specimen of *D. nakazawai* was derived from the "lenticular" limestone in the Mizuyagadani Formation, and that its age is Kazanian (middle Late Permian).

The abbreviation UMUT for the repository stands for the University Museum of the University of Tokyo.

Systematic paleontology

Order Orthocerida Kuhn, 1940

Superfamily Pseudorthocerataceae Flower and Caster, 1935

Family Pseudorthoceratidae Flower and Caster, 1935

Subfamily Spyroceratinae Shimizu and Obata, 1935

Genus *Dolorthoceras* Miller, 1931

Type species.—*Dolorthoceras circulare* Miller, 1931.

Dolorthoceras nakazawai sp. nov.

Figure 2

Diagnosis.—Species of *Dolorthoceras* with circular shell cross section; sutures oblique, attaining 16° to rectangular direction of shell axis; siphuncular position nearly central with asymmetrical septal necks; cameral deposits form circumsiphuncular ridge and mamiform growth; endosiphuncular deposits form thick lining on ventral siphuncular wall.

Description.—Orthoconic shell with circular cross section, reaches 7.4 mm in diameter near adoral end; shell expansion moderate with approximately 5° angle; shell surface

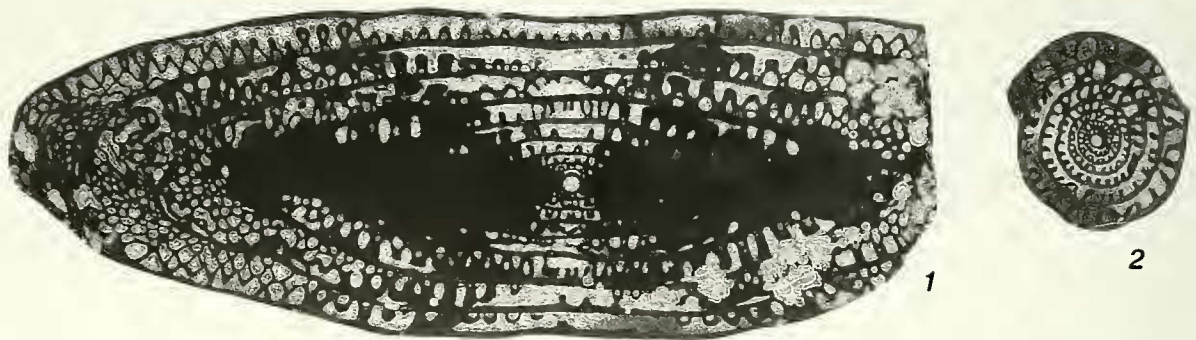
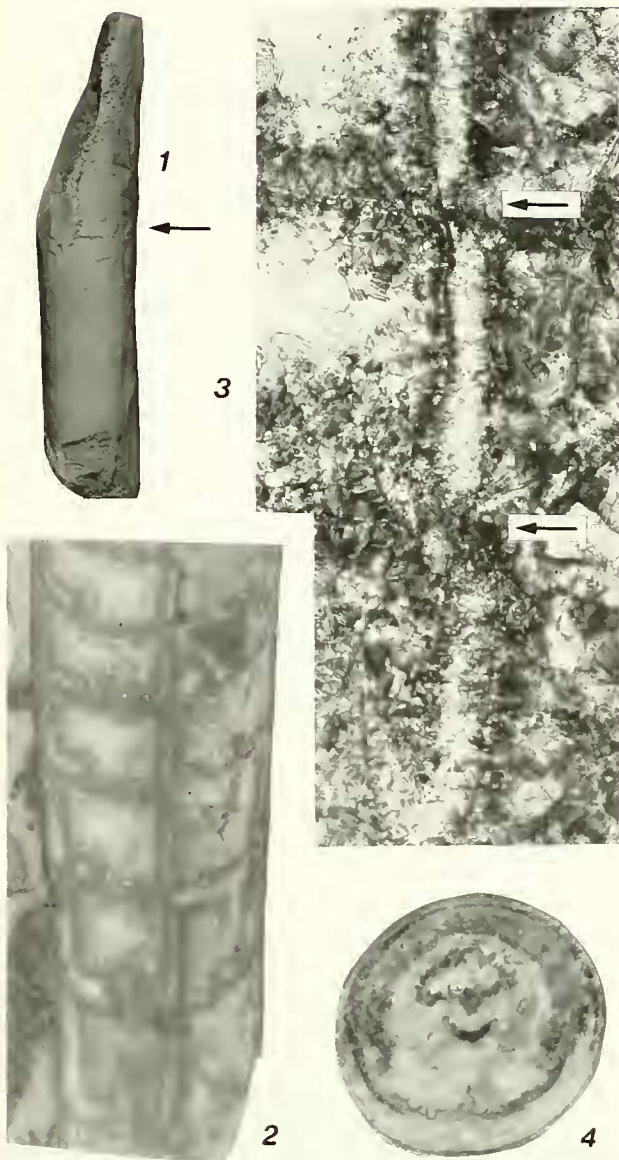


Figure 1. *Parafusulina* cf. *kaerimizensis* (Ozawa) from the Fukuji area, thin sections. 1. Axial section, $\times 10$. 2. Sagittal section, $\times 10$.



smooth, obvious ornamentation not recognized. Sutures not observed, but with relatively strong obliquity, ranging from 12° to 16° to rectangular direction of shell axis, as recognized in dorsoventral section, toward aperture on venter; septal curvature moderate to relatively deep, steeper in venter than dorsum; camerae relatively long for genus in apical phragmocone, with maximum width/length ratio 1.7 at shell diameter approximately 5.4 mm, being increased to 3.3 near adoral end. Siphuncle nearly central in position; septal necks asymmetrical in form, suborthochoanitic to rarely cyrtochoanitic in ventral siphuncular wall, and strongly curved cyrtochoanitic in dorsal siphuncular wall; length of septal necks short, ranging from 0.31 mm to 0.56 mm; brims short with length nearly equal to septal necks in adoral and ventral siphuncular wall, but in other portions they are shorter than septal necks; adnation area very narrow; connecting rings weakly inflated, subcylindrical with constrictions at septal foramina; ratio of maximum external diameter of connecting ring/corresponding shell diameter is approximately 0.2. Ventral cameral deposits well developed, episepal-mural or episepal and mural on rare occasions, always form circumsiphuncular ridge and mamiform growth; dorsal cameral deposits episepal-mural indicating L-shaped longitudinal profile, relatively thin. Endosiphuncular deposits restricted to ventral siphuncular wall, where they form a thick lining with crescentic transverse profile.

Discussion.—With the exception of *Dolorthoceras*, the relatively simple shell morphology of the present species has much in common with Late Paleozoic *Spyroceratinae* such as *Adnatoceras* (Flower, 1939), *Euloxoceras* (Miller et al., 1933), *Mitorthoceras* (Gordon, 1960) and *Shikhanoceras* (Shimanskiy, 1954). However, the combination of an uncompressed shell with a smooth surface, the very narrow adnation area and the short brims confirms the assignment

Figure 2. *Dolorthoceras nakazawai* sp. nov., holotype, UMUT PM 27826, from the Fukuji area. 1. Ventral view, $\times 2$. 2. Dorsoventral thin section, venter on right, $\times 5$. 3. Dorsoventral thin section, showing the details of the siphuncular structure. Arrows indicate septal necks, $\times 14$. 4. Transverse polished section at position indicated by arrow in Figure 2.1, venter down, $\times 5$.

of the species to *Dolorthoceras*, which was proposed by Miller (1931) from the Upper Carboniferous in the Aghil-Depsang (Central Range) of Central Asia. Its previously known range was Early Devonian to Early Permian, with an upper limit represented by two Artinskian species from the Urals, namely *Dolorthoceras siphocentrale* (Krotov, 1885, pl. 1, fig. 3; Shimanskiy, 1954, pl. 1, figs. 11, 12a, b) and *D. stiliforme* Shimanskiy (1948, figs. 1a, b; Shimanskiy, 1954, pl. 1, figs. 1–10, pl. 2, figs. 1–6). Thus, the present discovery of *Dolorthoceras* in the Mizuyagadani Formation extends the stratigraphic range of this genus upwards to the Kazanian.

The somewhat similar *Dolorthoceras stiliforme* is distinguished from *D. nakazawai* sp. nov. in having a subcentral siphuncular position, the usually simple mural cameral deposits and the unfused endosiphuncular deposits. Niko and Nishida (1987, fig. 3.3–3.5) assigned a specimen from the same formation to an indeterminate genus and species of the Pseudorthoceratidae having the surface annulation clearly separate from *D. nakazawai* at the generic level.

A poorly preserved specimen of *Dolorthoceras*? sp. from the Early Carboniferous Hikoroichi Formation in the southern Kitakami Mountains (Niko, 1990) was the only record of this genus in Japan until the present report.

Material.—Holotype and only known specimen, UMUT PM 27826, is an incomplete phragmocone 37.2 mm in length.

Etymology.—The specific name honors Dr. Keiji Nakazawa, in recognition of his contributions to the study of Permian mollusks.

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